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Geological mapping of Mawrth Vallis, Mars, by PLANMAP

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Introduction

Mawrth Vallis is generally considered to be the oldest of Mars' outflow channels [1]. It incises Noachian (> 3.7 Ga) terrain and is associated with thick (> 150 m), clay-bearing deposits [2]. Clays are important astrobiologically because they are potential catalytic substrates for (pre)biotic chemistry [3] and have a high potential to preserve biosignatures [4]. The presence of clay-bearing deposits was an important factor in the decision to shortlist an area adjacent to Mawrth Vallis as a candidate landing site for the ExoMars "Rosalind Franklin" rover [5], whose mission is to search for signs of ancient life on Mars [6]. Ultimately, Mawrth Vallis was not selected as the ExoMars landing site.

The origin and geological context of the clay-bearing deposits is not well understood [7]. Furthermore, the geomorphology of Mawrth Vallis, which records its history of deposition/burial and erosion/exhumation, is also less well-studied compared with its mineralogy. Here, we present our ongoing geological mapping of Mawrth Vallis, which we are conducting to investigate the relationship between the channel and the clay-bearing deposits. We are producing a detailed map of the main Mawrth Vallis channel adjacent to the proposed ExoMars landing ellipse. We will also produce an accompanying geomorphic feature map along the whole length of Mawrth Vallis at a smaller scale.

We are creating this map as part of the Planmap project [8], which aims to provide standards for European researchers to adhere to in order to aid the dissemination of their maps. Planmap is producing exemplar maps of Mercury [e.g. 9], the Moon [e.g. 10], and Mars [e.g. this work], where various datasets (visual images, elevation models, spectra, crater size-frequency distributions) will be fused to make more fully-intergrated geological maps. The abundance and diversity of data types at Mawrth Vallis, in addition to its scientific interest, make this region particularly suitable for Planmap.

Data

We are using a ~6 m/pixel orthorectified CTX [11] mosaic basemap, supplemented by 25–50 cm/pixel HiRISE images [12], ~4 m/pixel colour CaSSIS images [13], and ~20 m/pixel CTX digital elevation models (DEMs).

Methods

We are mapping using ArcGIS 10.6.1. Mawrth Vallis spans 340°E–247°E and 18°N–26°N. We are mapping in a stereographic projection centred on 343°E, 22.4°N. We are digitising the main map on

the CTX mosaic at 1:20,000-scale (~full CTX resolution), and intend to publish the map at ~1:100,000-scale. The geomorphic feature map will be published alongside the main map. We will use HiRISE and CaSSIS images to aid unit definition and CTX DEMs to aid stratigraphic interpretation.

Results and future work

Figure 1 shows the current state of our map.

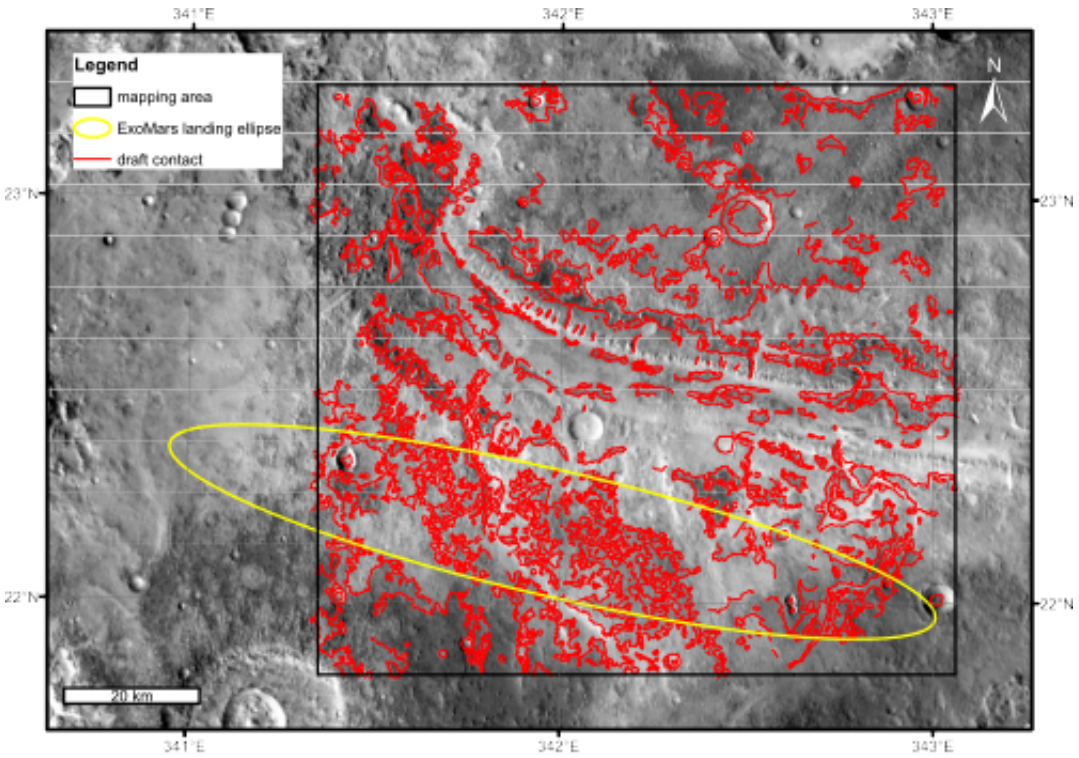

Figure 1. Draft contacts (red) in our geological map of Mawrth Vallis adjacent to the ExoMars candidate landing ellipse (yellow). Main mapping area outlined in black.

We plan to begin work on the geomorphic feature map soon. Progress on the main map will continue in parallel. We will investigate the stratigraphic position of Mawrth Vallis relative to the large impact craters in the region. We will consider how the stubby depressions that occur with the main channel's walls formed.

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